Surfers Beach and Miramar

Half Moon Bay

(El Granada and Half Moon Bay, CA)

Bob Battalio, PE

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Environmental Science Associates (ESA)
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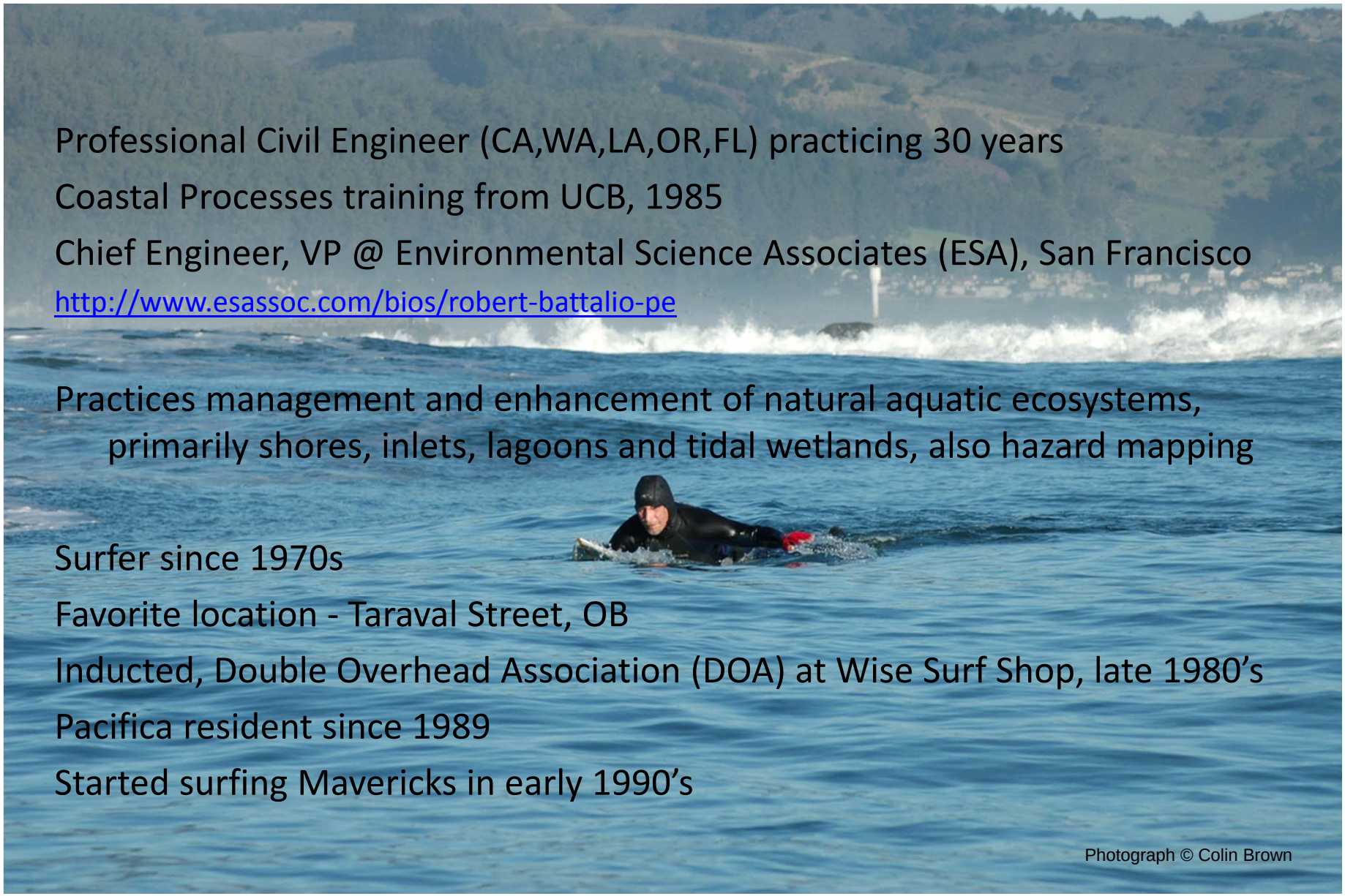
Coastside Sea Rise & Erosion Forum
Douglas Beach House in Miramar,
May 24, 2016

Who is this dude ?



Professional Civil Engineer (CA,WA,LA,OR,FL) practicing 30 years

Coastal Processes training from UCB, 1985

Chief Engineer, VP @ Environmental Science Associates (ESA), San Francisco

http://www.esassoc.com/bios/robert-battalio-pe

Practices management and enhancement of natural aquatic ecosystems, primarily shores, inlets, lagoons and tidal wetlands, also hazard mapping

Surfer since 1970s

Favorite location - Taraval Street, OB

Inducted, Double Overhead Association (DOA) at Wise Surf Shop, late 1980's

Pacifica resident since 1989

Started surfing Mavericks in early 1990's

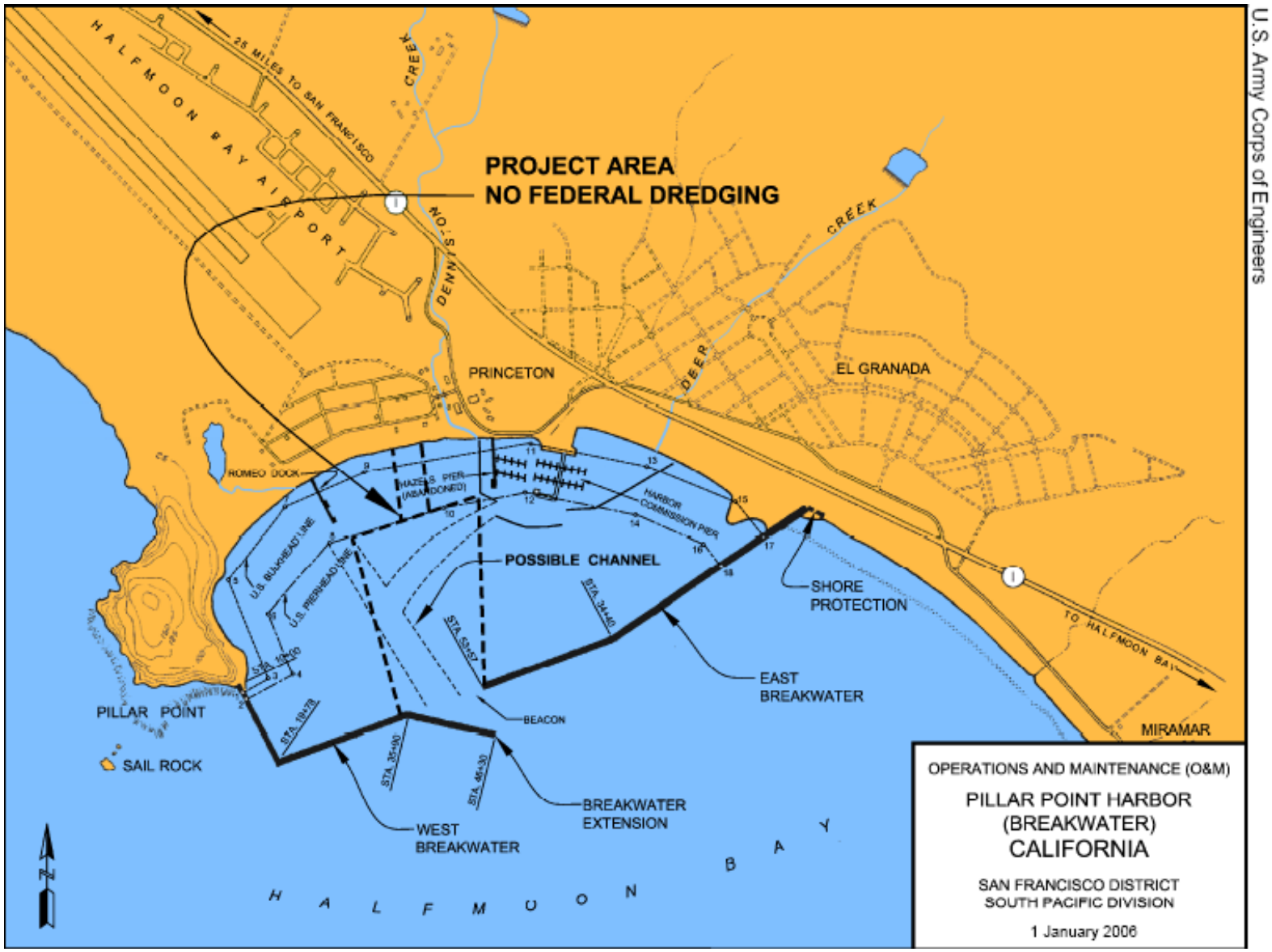
Problem(s) statement

- Pillar point harbor
  - Traps sand supply to HMB littoral subcell, causing sediment deficit and erosion
  - Breakwater causes wave reflection which increases longshore transport toward south
- Shore armoring on Coast Highway and Mirada Road
  - Increase wave reflection, increase longshore transport south and offshore, lowers beach
  - Erosion will accelerate in unarmored areas
- Climate change, Sea level rise – everything gets worse (maybe not depths for navigation)
- Result
  - Shoaling in Pillar Point Harbor
  - Erosion hot spot at surfers beach and Miramar
  - Increased erosion in southern HMB
  - Wave reflection from breakwater improves surf locally (not a problem)
  - Wave reflection from shore armoring degrades beach and surf
  - Reduced beach and surf access, safety issue
  - Wave overtopping and damages to roads, utilities and structures

Littoral (shore) processes

- HMB is a hook-shaped bay between headlands
- Hook-shaped bay formed by wave refraction and diffraction affecting shore erosion
- Sediment discharge from streams important sediment supply
- Discharge from streams form deltaic perturbations from hook-shape
- Pre-harbor: Waves smooth-out perturbations, transport sand southward
- Waves and Sand can move through breakwaters
- Sand deposits in sheltered areas

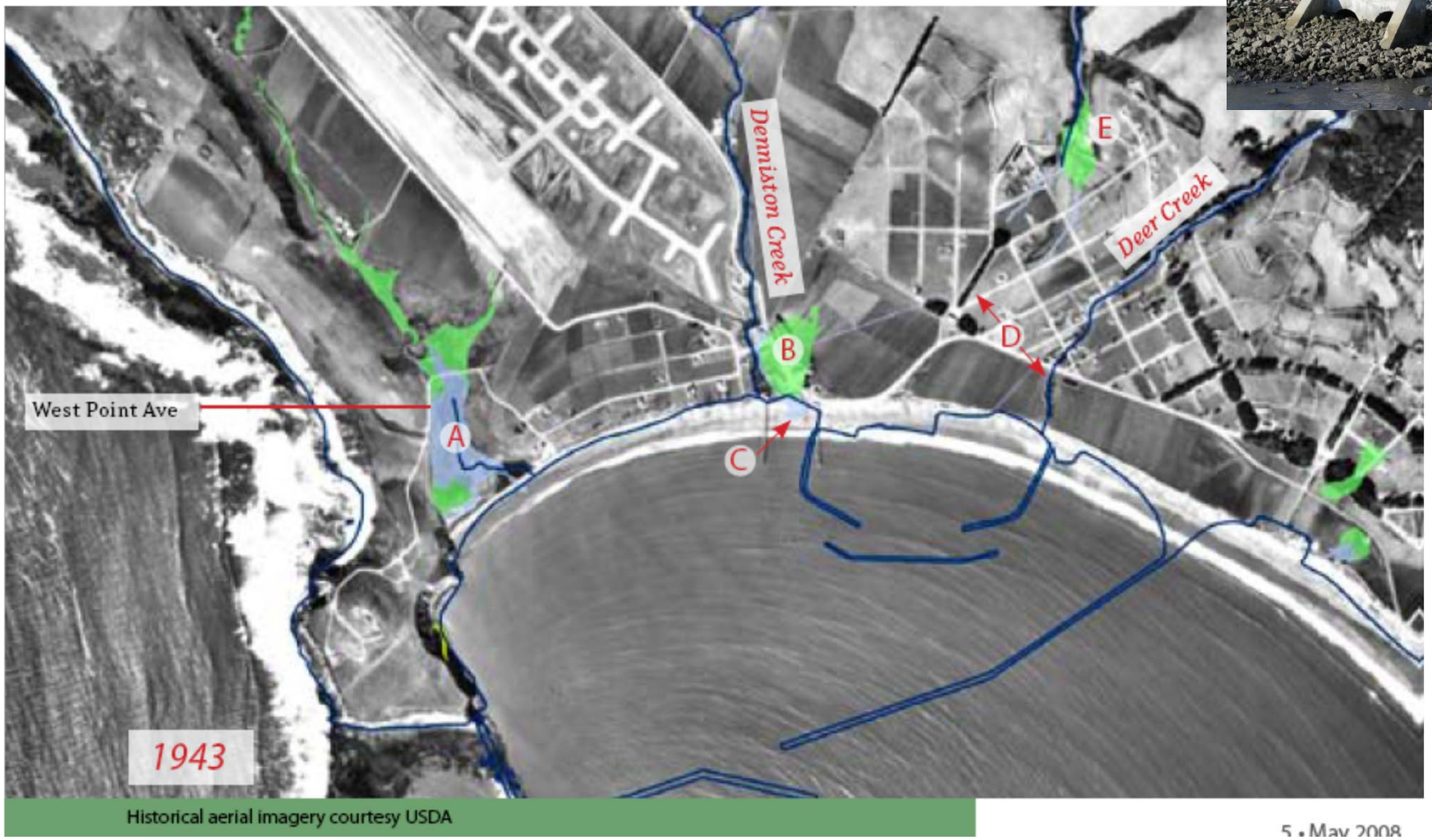
Pillar Point Harbor



U.S. Army Corps of Engineers

Creeks and historic conditions

Deer Creek outfall at Boat Launch Ramp→

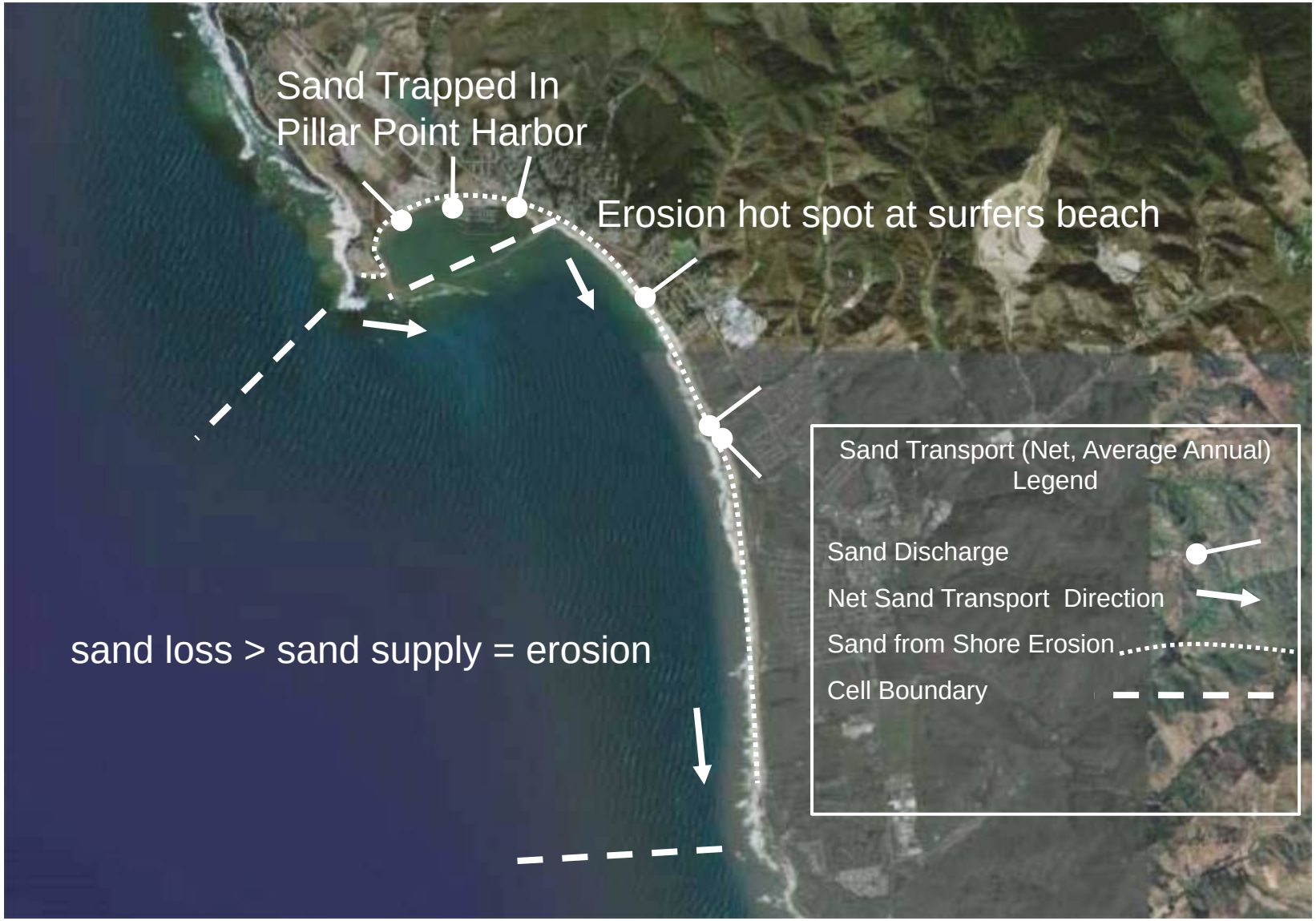


Source: SFEI

Sand Deposits circa 2005

Half Moon Bay

Half Moon Bay Littoral Cell

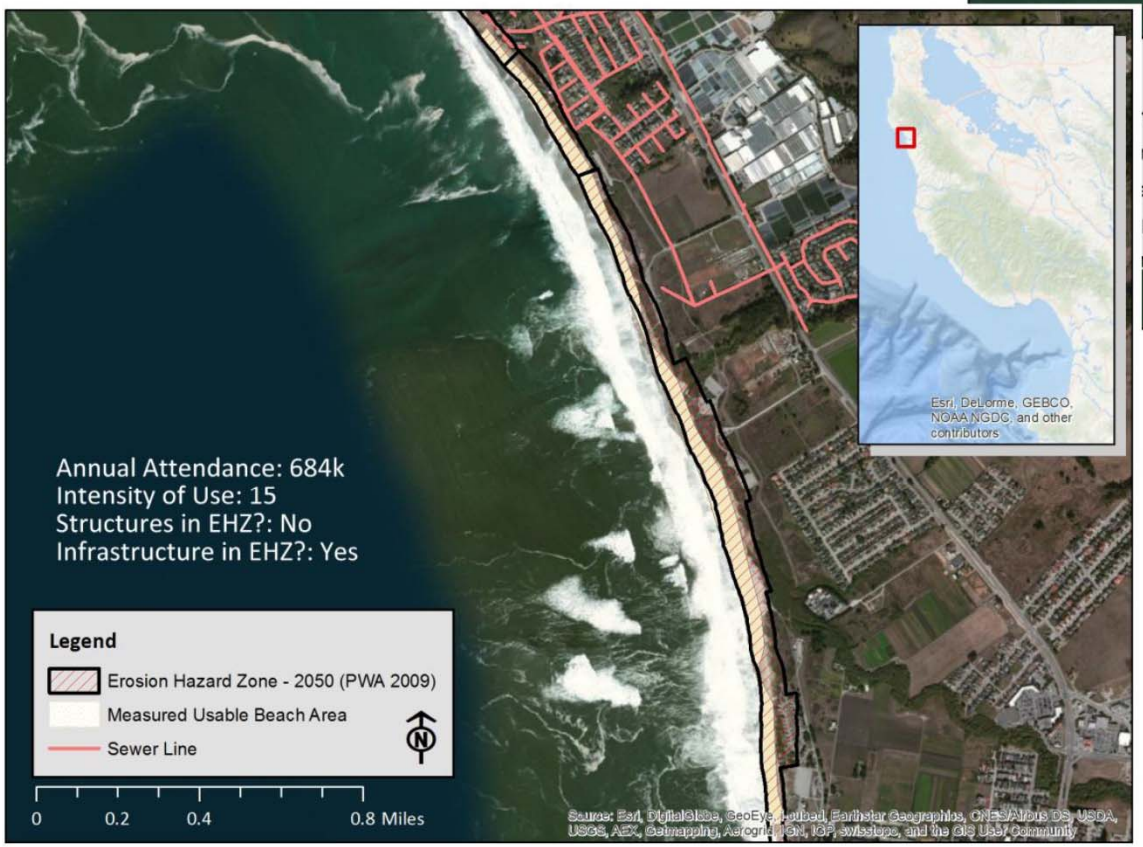


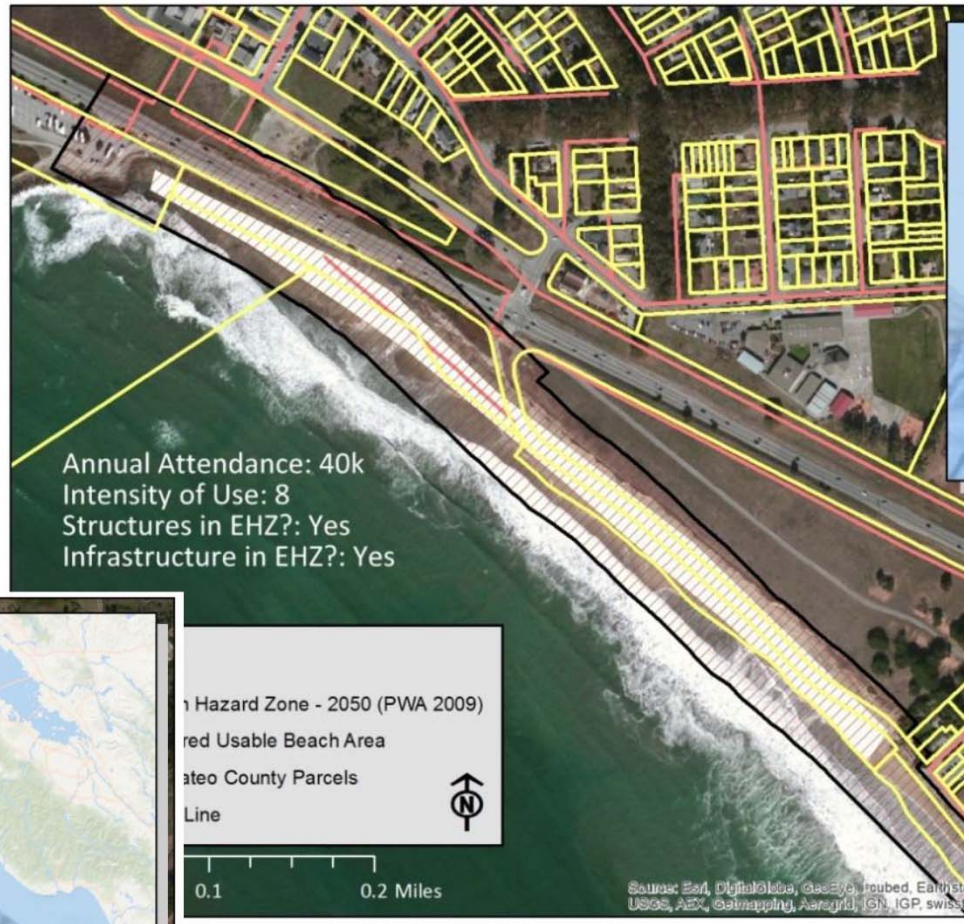
Surf at surfers beach

- Protected from predominate northwest wind
- Reduced swell exposure due to sheltering by Pillar Point and offshore reef
- Reflection from breakwater causes wave crossing and peaky breakers that peal
- Especially good on south and southwest swells due to exposure plus reflection

Wave Reflection

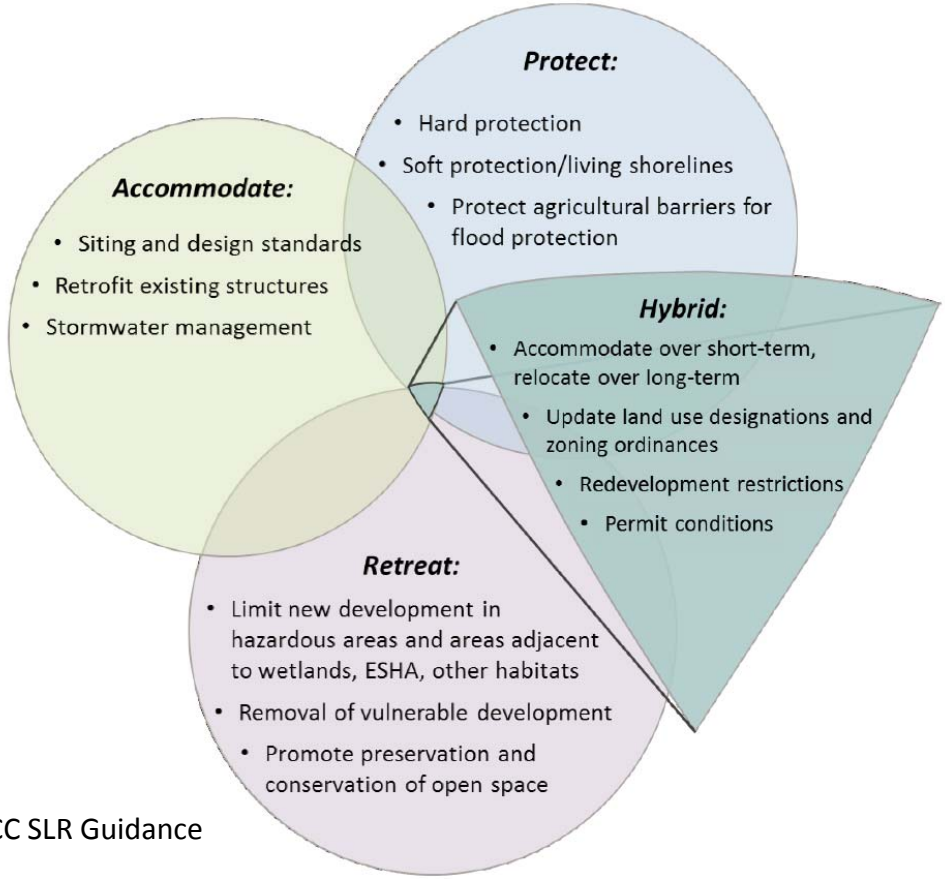
Pacific Institute erosion projection 2050



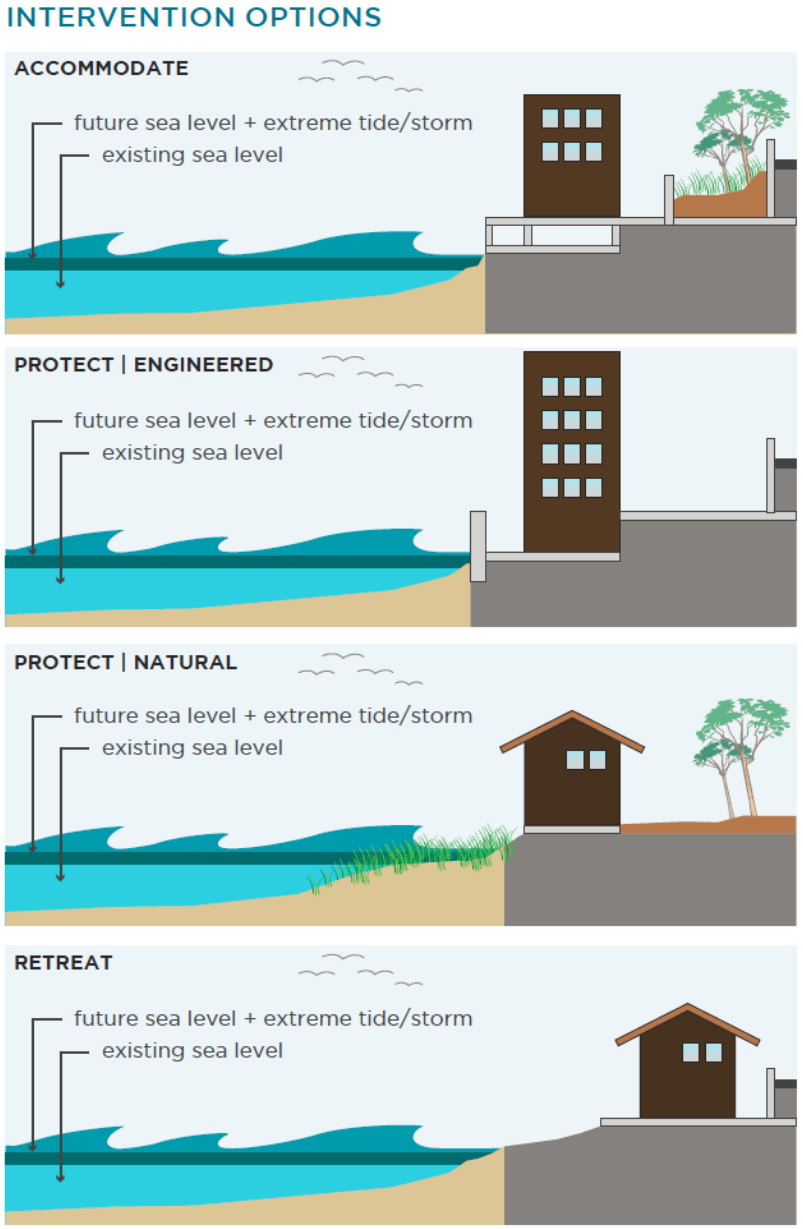


Source: USACE RSM, 2015

Adaptation Strategies

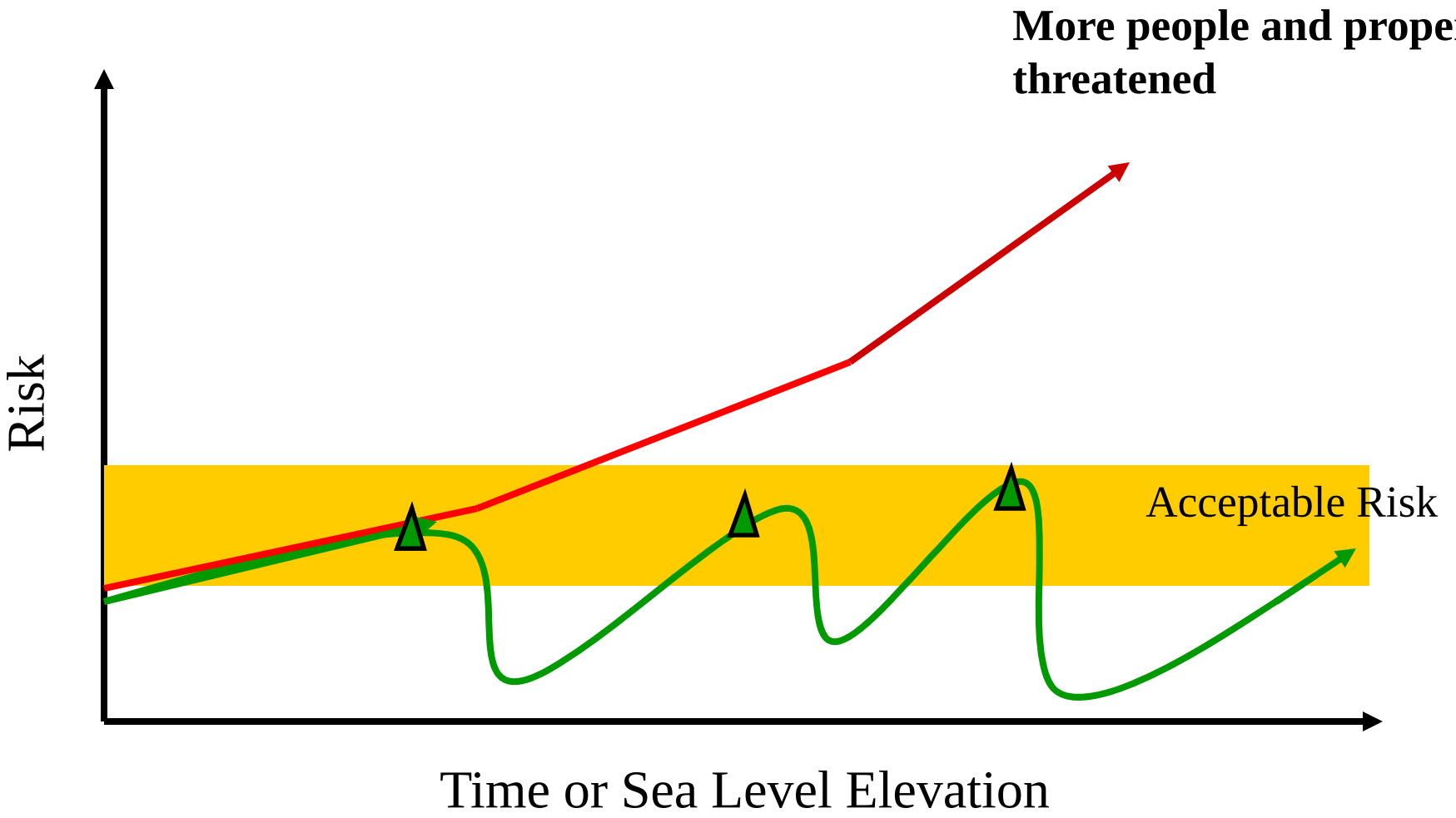


CCC SLR Guidance



SAN FRANCISCO SEA LEVEL RISE ACTION PLAN

Adaptation to Manage Risk Over Time



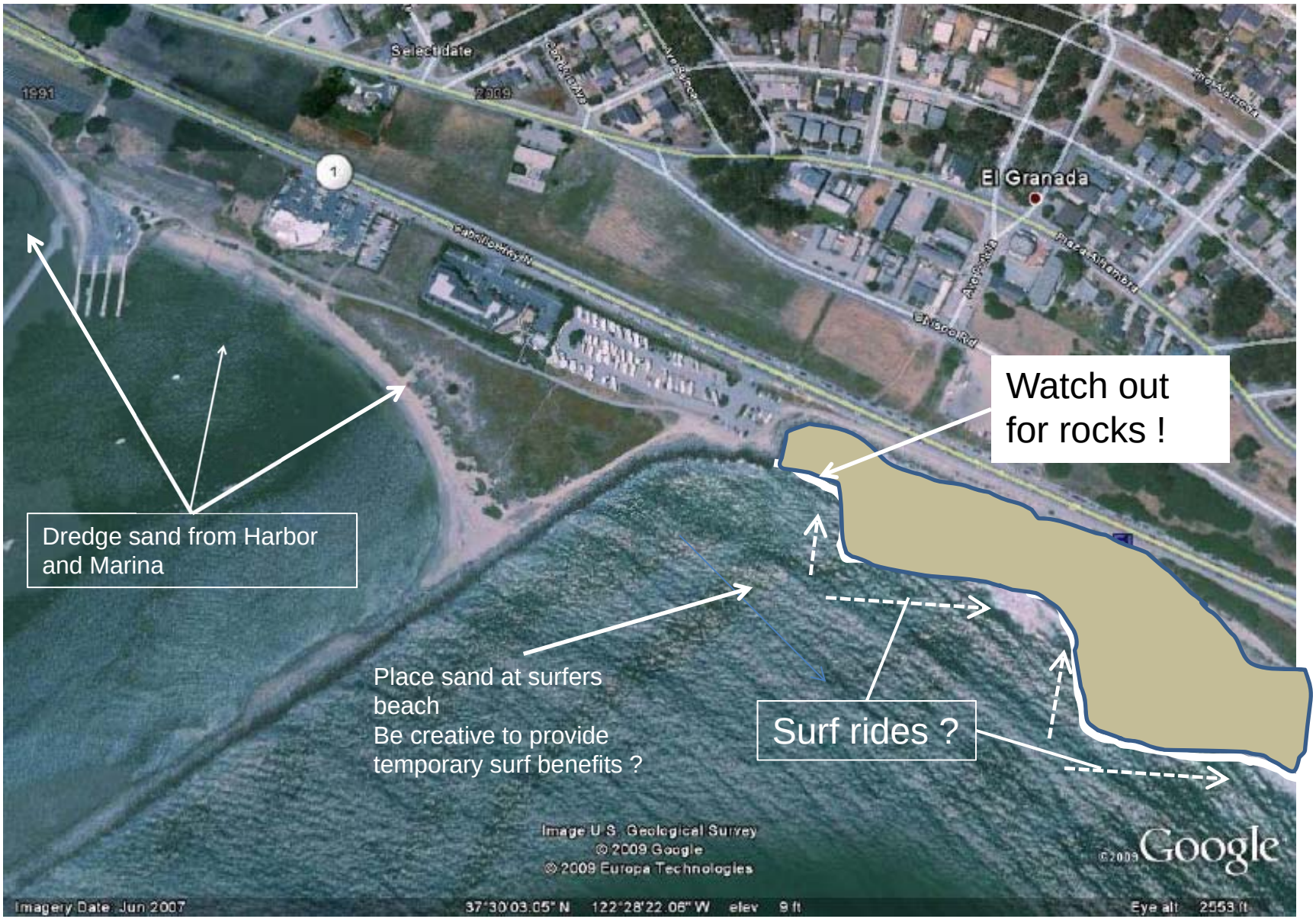
Adaptation Strategies (options, measures, building blocks for alternatives / scenarios)

1. Accommodation (structural adaptation)
2. Armor
   A. Shore – seawall, rock revetment
   B. Headland – armored area, jetty
   C. Offshore – breakwater, reef
3. Beach nourishment (sand placement)
   A. Beach
   B. “Dune” backshore
4. Retreat

Alternatives – Conceptual Examples (scenarios)

- Armor road / shore
- Bypass sand / beach nourishment
- Reroute deer creek
- Anchor shore with sand retention structures
- Offshore breakwaters
- Offshore reef
- Accommodation via Structural adaptation
- Reroute highway 1, managed retreat
- Remove harbor breakwater(s)

Creative Sand Placement

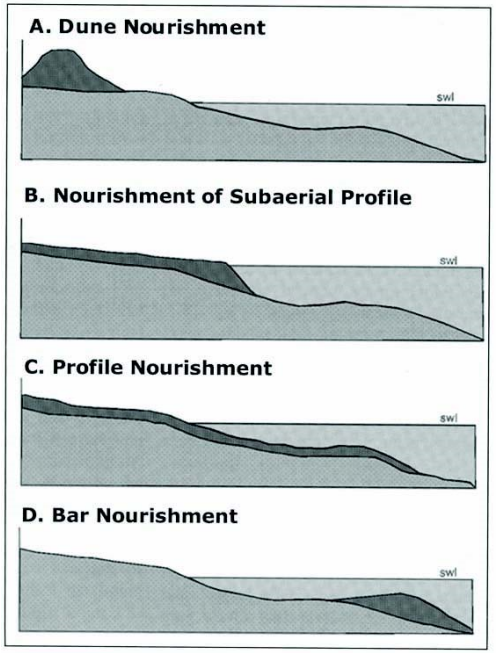


Beach Nourishment

Carlsbad, CA

- Placement of sediment-water slurry directly on beach or beach face; mechanical placement of sand, gravel and cobble
- Key questions:
  - Sediment characteristics and sources
  - Longevity, frequency

Opportunities	Constraints
Use sediment trapped in harbor	Permitting – new work
Use offshore sediment ?	Sand sources
Rebuild cobble lag, dunes	Immediate, short-term biological impacts
	Habitat conversion long-term



Finkl, Benedet and Campbell, 2006

“Sacrificial” sand embankment placement

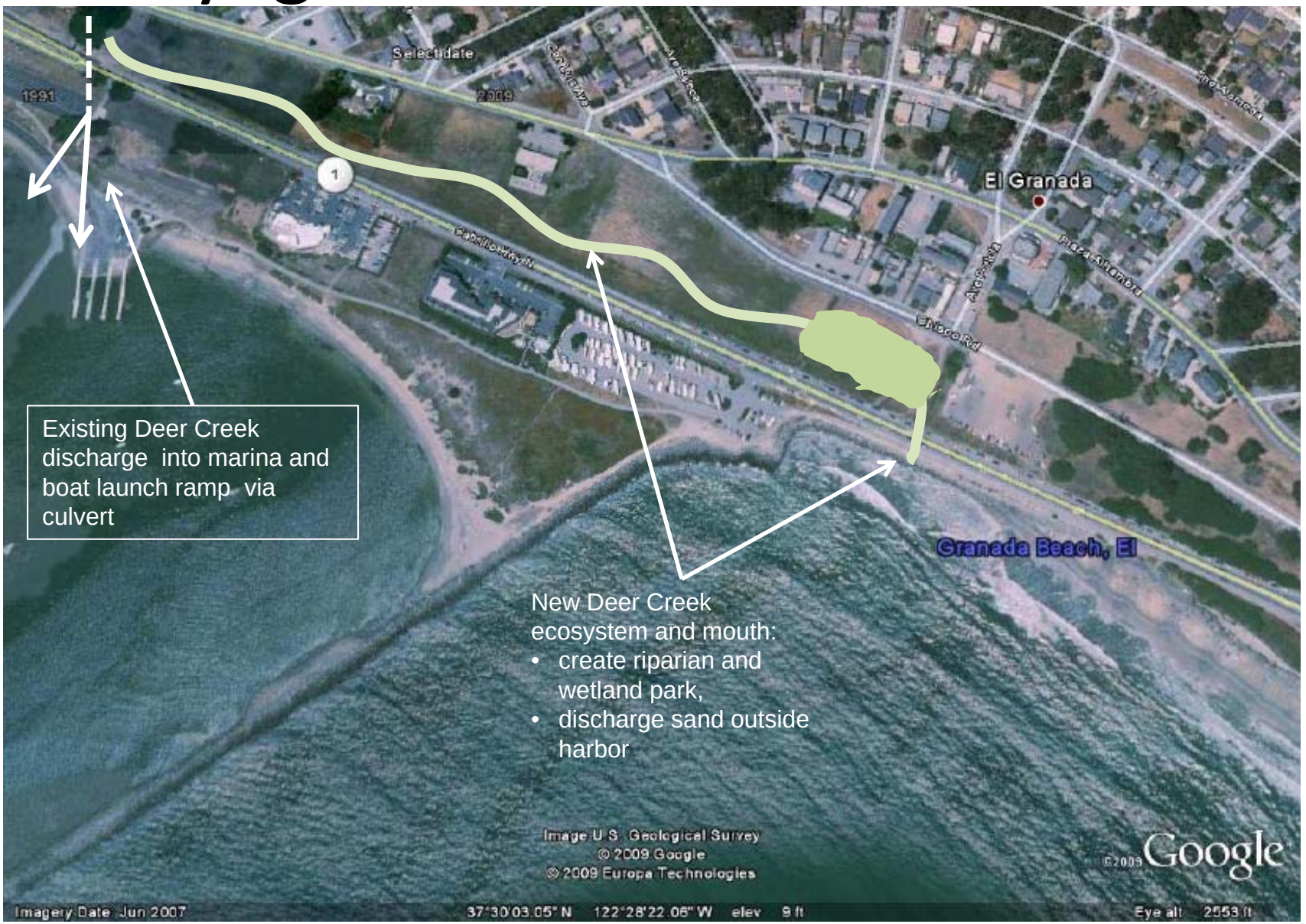
Goleta Beach, Santa Barbara County
2015-16

south Ocean Beach, San Francisco
Sand Placement –

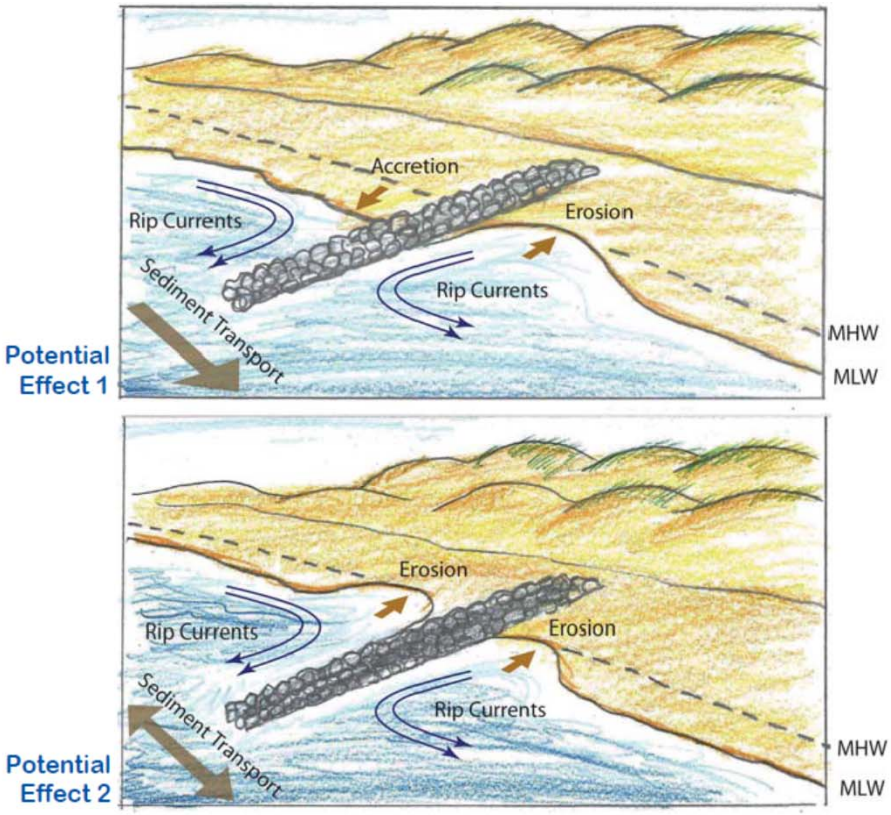
- 1999
- 2001
- 2012
- 2014-15
- 2015-16

Photographs: Bob Battalio

Daylight and Reroute Deer Creek



"sand retention structures", jetties, groynes, headlands

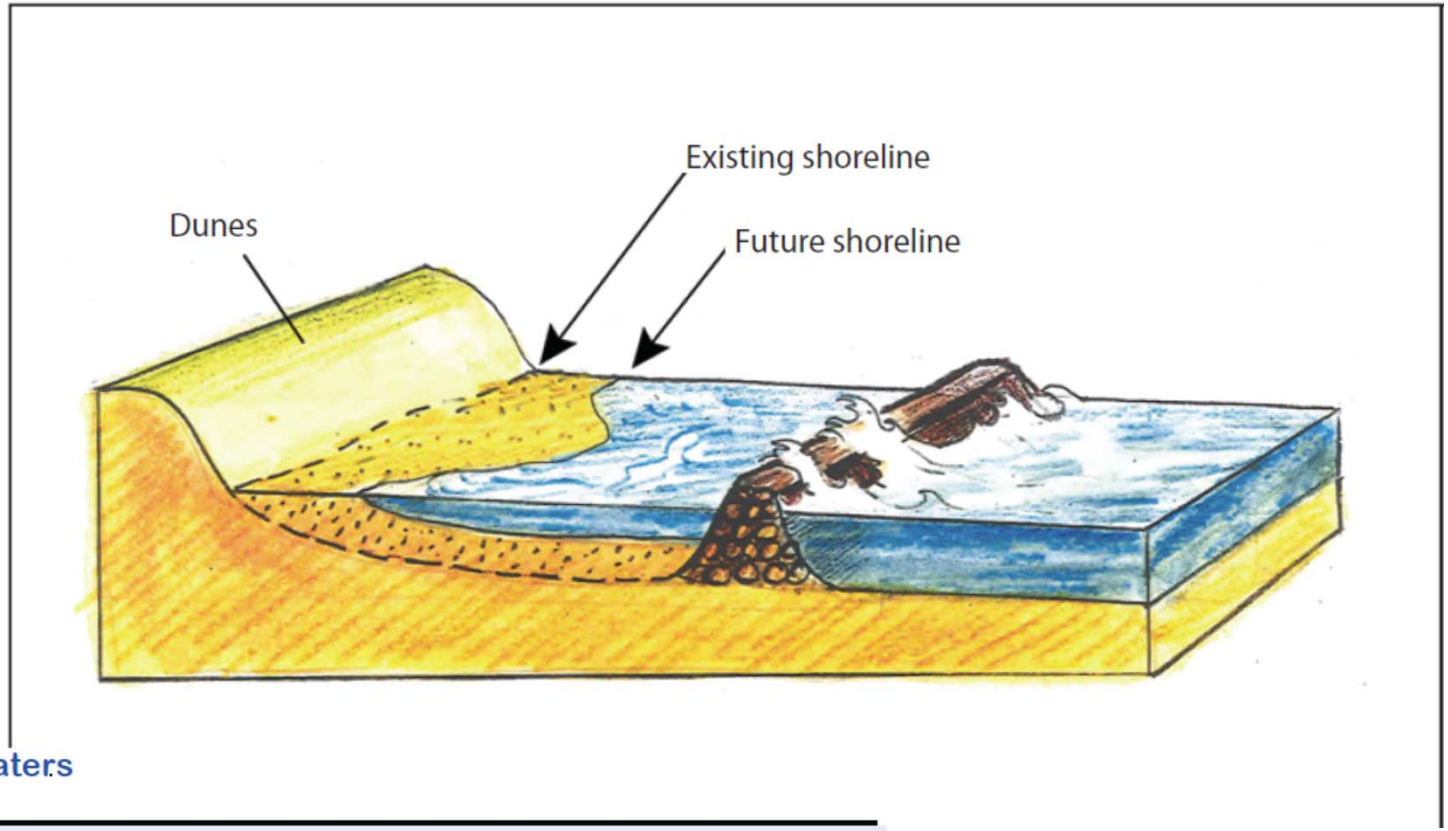


Characteristics of Groins

Reduce threat to structures	Yes generally in areas updrift of structure
Maintain Beach Width	Potentially improves updrift, narrows downdrift unless updrift is at full carrying capacity
Economic Costs	High
Environmental Impacts	Yes
Recreational	Potential benefits to beach width and surfing
Safety and Public Access	Impacts from rip current generation, and lateral access
Aesthetics	Impacts
Regulatory Viability	Uncertain
Adaptability to Future Conditions	Depends on rates of climate change, likely not in medium/long term
Cumulative Impacts	Likely downcoast erosion impacts. One groin usually leads to fields of groins, a reasonable expectation of long term buildout of groin field
Certainty of Success	For areas with mainly uni-directional transport, and with pre-filling of the accretion fillet: Certain in short term, less certain in medium/long term

Source: ESA 2012; San Francisco Littoral Cell study

Offshore Breakwaters

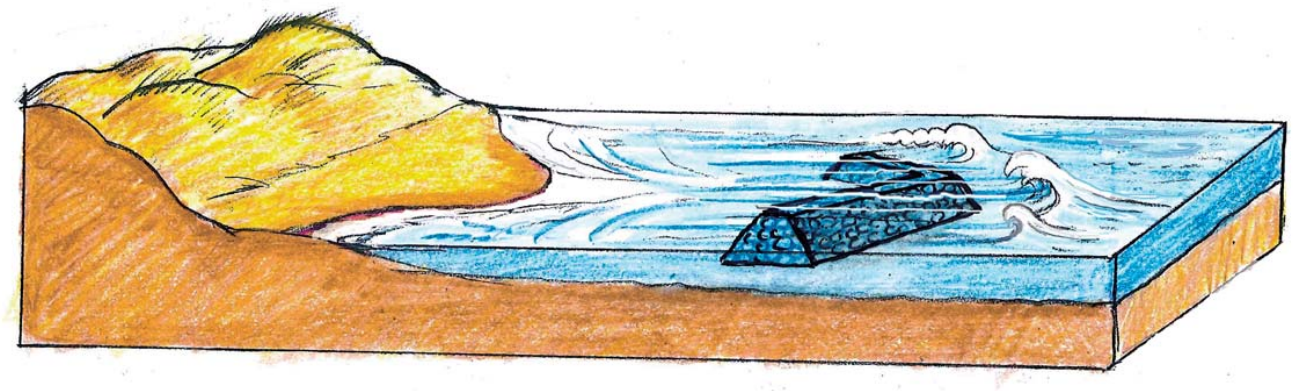


Characteristics of Breakwaters

Reduce threat to structures	Yes
Maintain Beach Width	Yes to improves
Economic Costs	High
Environmental Impacts	Yes – sand to rock habitat, potential to become a sink of sediment until equilibrium is reached
Recreational	Benefits to beach recreation and potentially swimming and fishing, impacts to surfing and boating
Safety and Public Access	Reduces wave energy, promotes calmer waters
Aesthetics	Impacts
Regulatory Viability	Uncertain
Adaptability to Future Conditions	Eventually become submerged breakwater
Cumulative Impacts	Depends on scale of breakwater, a breakwater may also lead to additional structures
Certainty of Success	Certain

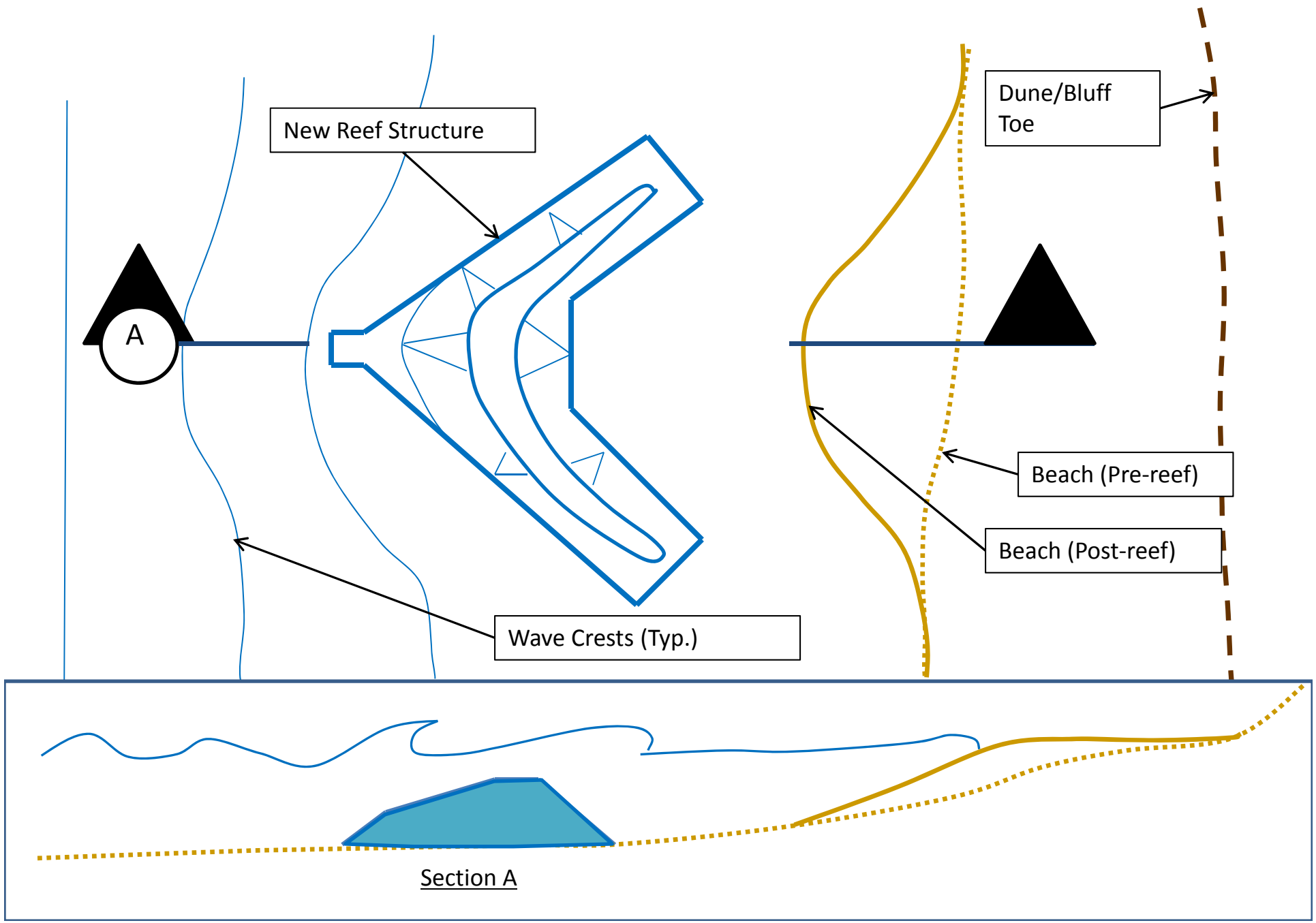
Source: ESA 2012; San Francisco Littoral Cell study

Multi-purpose Reefs



Opportunities	Constraints
Create new habitat	High energy coastline
Enhance surf opportunities	Limited experience
Increase sediment retention	High cost (economic and environmental)
	Safety, liablity

Artificial Reef – Plan and Section



armoring

Pleasure Point, Santa Cruz: Source: USACE RSM, 2015

Sea Walls

>30 years old , Beach Boulevard, Pacifica

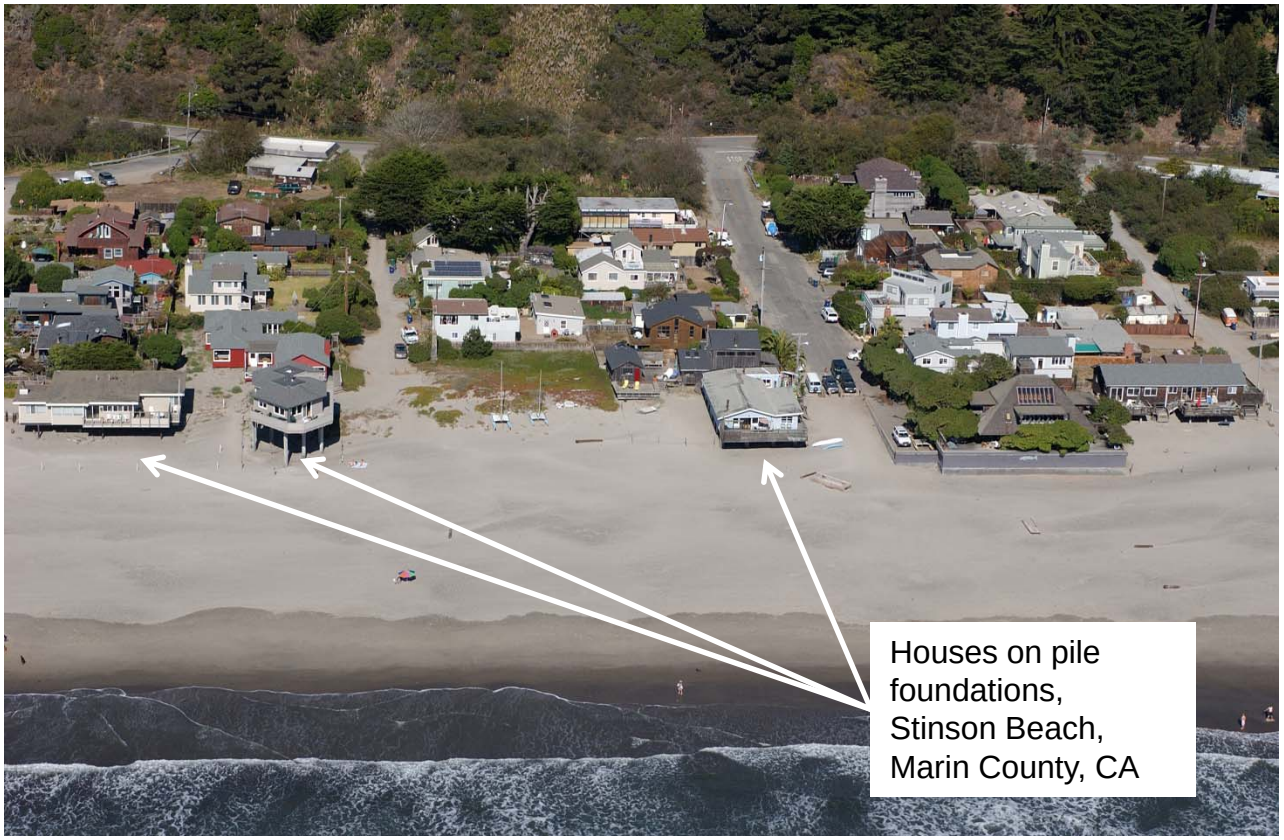
< 10 years old, Pleasure Point, Santa Cruz

Pros	Cons
• "Holds the line" • Protects homes, roads, utilities in place (?) for a while • Technically feasible and permit-able	• Beach loss over time • Higher impacts, changed shore type • Future costs to adjust to sea level rise • Potential catastrophic failure

Armoring can fail

Photographs: Beach Boulevard, Pacifica, CA, January 22, 2016. © Battalio 2016

Accommodation - Structural Modification



Structural Adaptation is the modification of the design, construction and placement of structures sited in or near coastal hazardous areas to improve their durability and/or facilitate their eventual removal. Structural examples include raised buildings on pile foundations, moving buildings inland.

Structural Adaptation / Retreat

- Building relocation
- Underpin with pile foundation
- Other ?

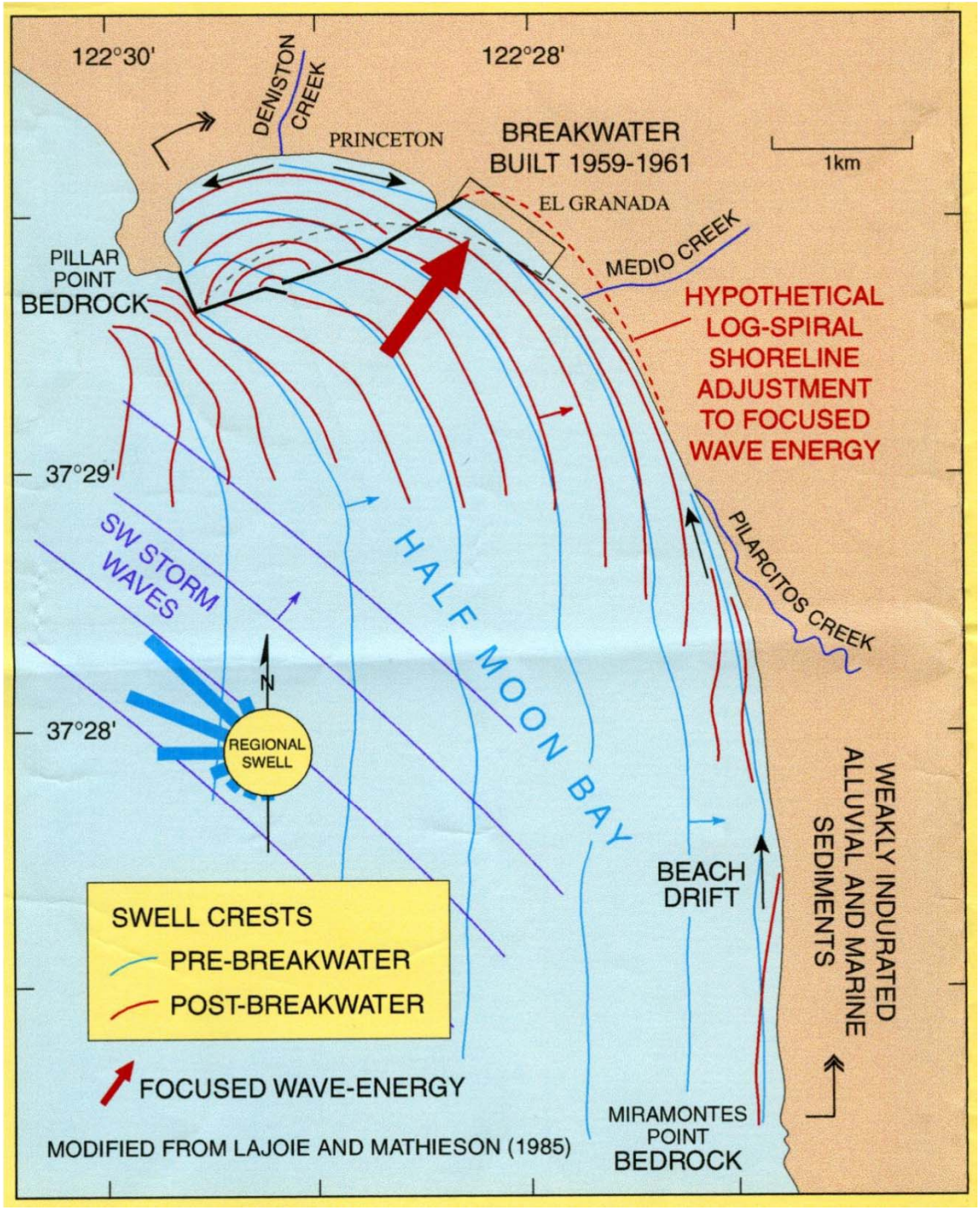
Building in process of being moved, Esplanade Ave, Pacifica, CA .
Photos: Bob Battalio, May, 2016.

Managed Retreat

- Phase – in over time
- Realign infrastructure (e.g., move road up / in)
- Relocate and compensate at risk development
  - Rolling easements
  - Relocation incentive programs
  - Transfer of development rights programs
  - Acquisition and buyout programs
- Allow shore to move inland

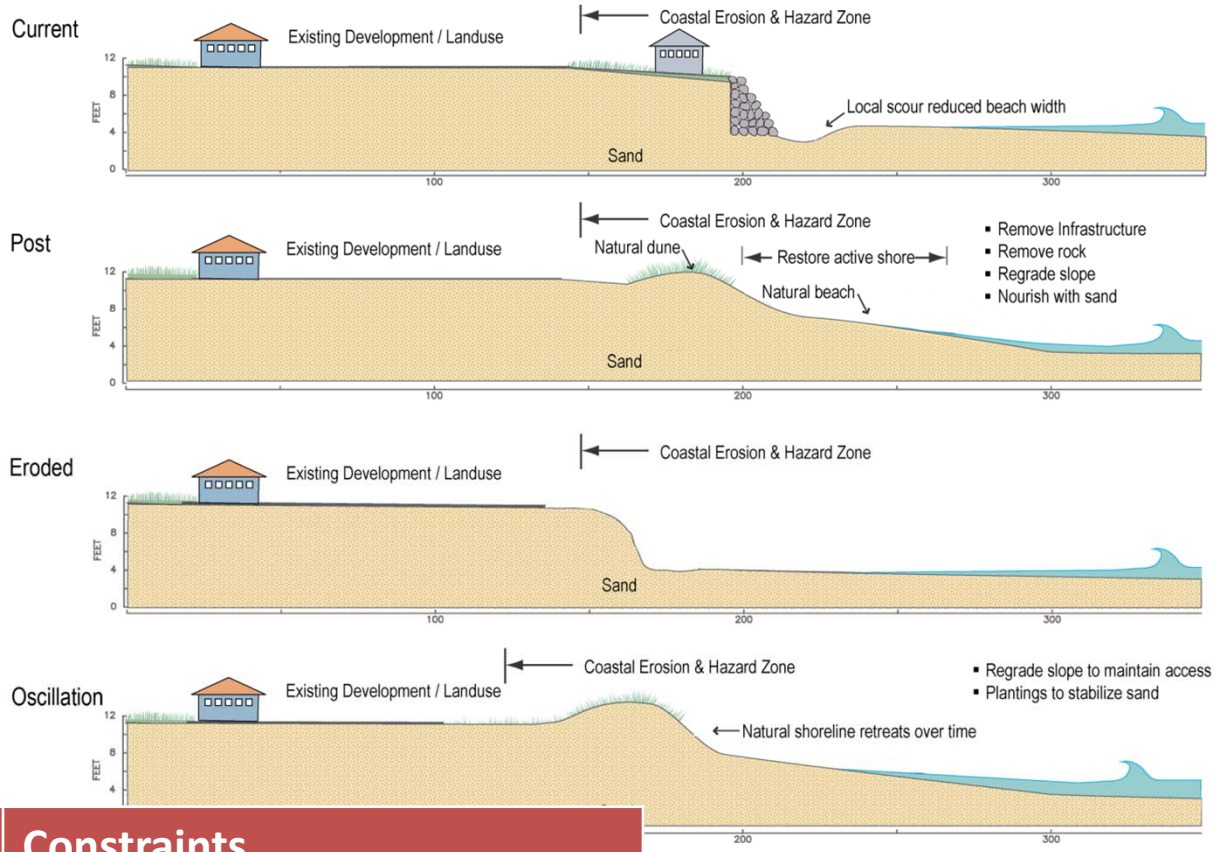
Pros	Cons
• Preserves beach • Lowest impact to coastal resources	• Private property considerations • Institutional and cultural resistance

Allow erosion - retreat



Source: USACE, 2009, NORTHERN HALF MOON BAY SHORELINE IMPROVEMENT PROJECT PILLAR POINT HARBOR, CA SF;CTION 216 REVIEW OF COMPLETED PROJECTS, INITIAL APPRAISAL, JULY 2009

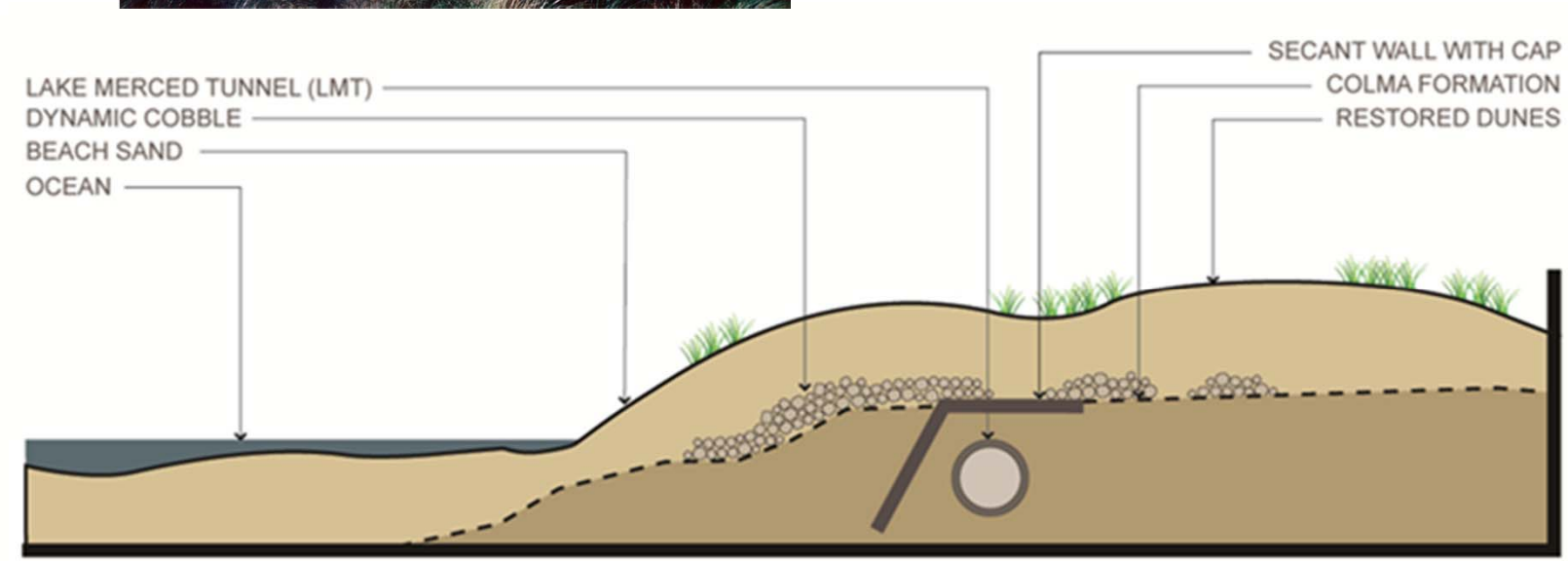
Managed Retreat



Opportunities	Constraints
Restoration of natural shoreline cycles and habitats Utilize geology Removal/reduction of development in risk zones Prior investments in armoring	Expense Political will Property rights Existing armoring

Managed Retreat can include structures

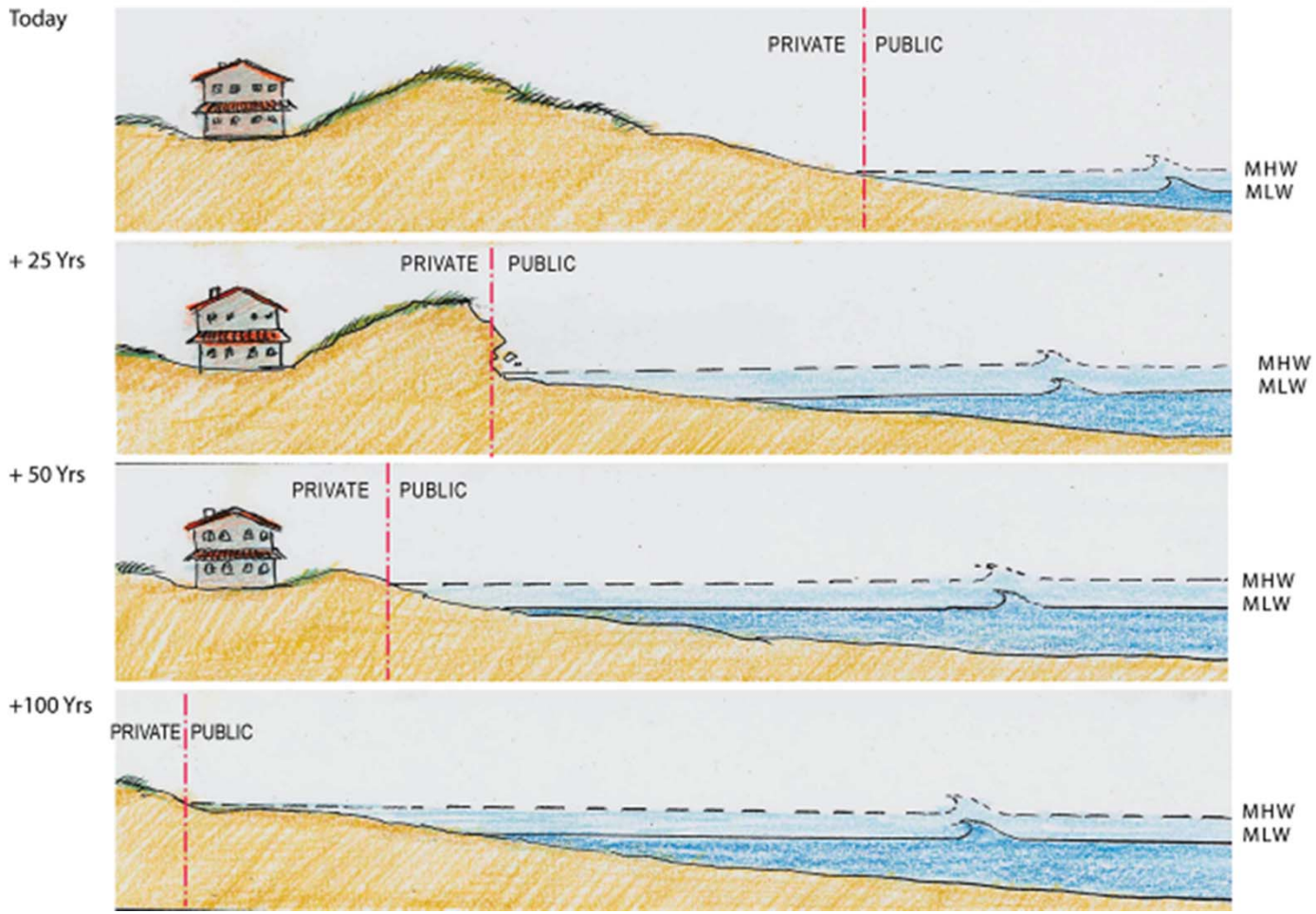
Photos: Battalio, 1990s (left) and 2000s (right)



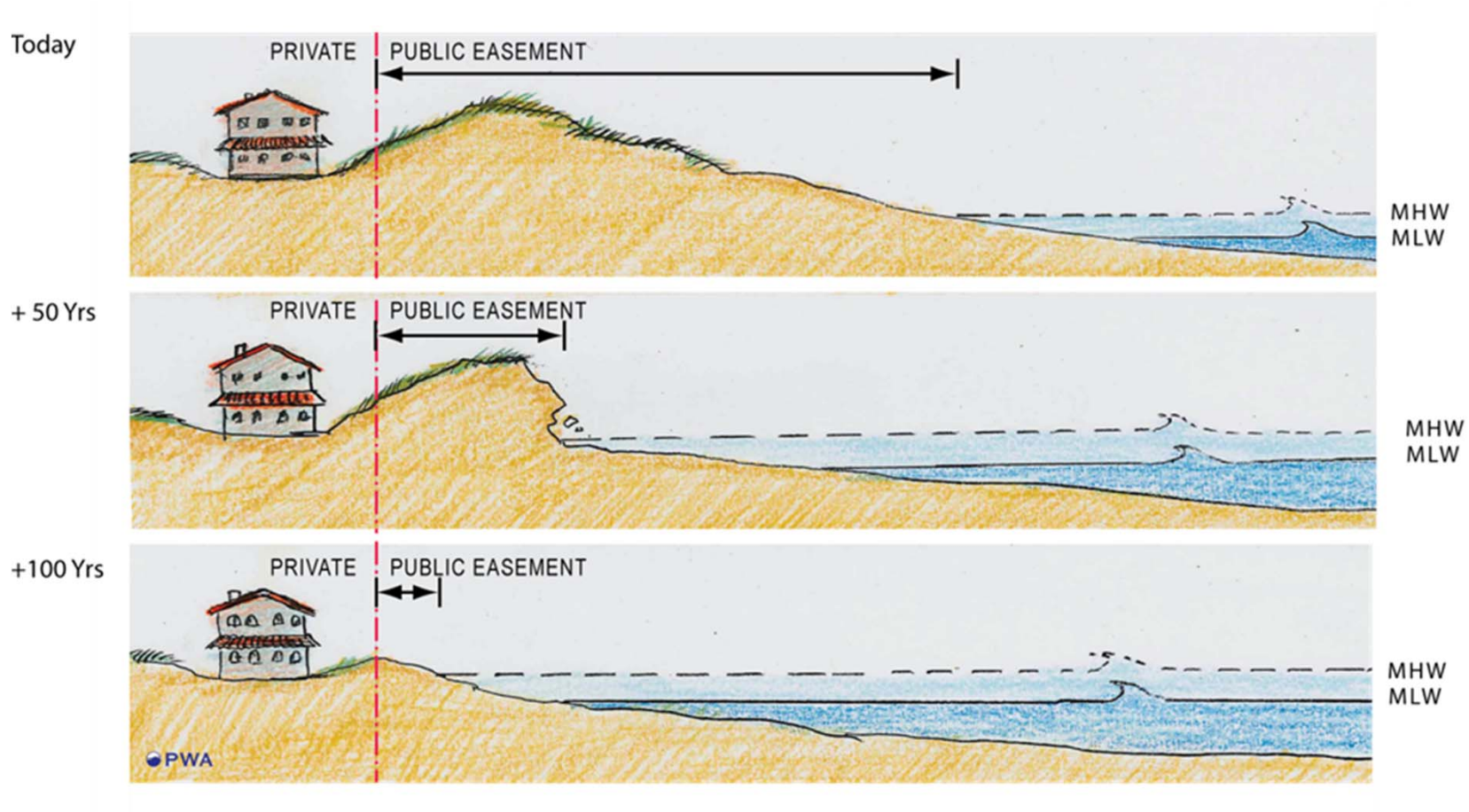
Ocean Beach Master Plan (San Francisco) Future condition after removal of rubble, fill and roadway

Rolling Easement

Rolling Easements are open space or conservation easements that move or ambulate with some identified reference feature



Parcel-based Conservation Easement



A conservation easement is a legally enforceable agreement attached to the property deed between a landowner and a government agency or a non-profit organization that restricts development “for perpetuity” but allows the landowner to retain ownership of the land.

Recommendation - Preliminary

- Bypass sand from Harbor
- Interim management
- Adaptation Scenario Planning
  - Beach Nourishment
  - Daylight and Reroute Deer Creek
  - Setback / Reroute / Elevate Highway 1
  - Accommodation with development and coastal structures
  - Managed retreat of development

Bob Battalio at Mavericks 2007. Photograph © Frank Quirarte, 2008

Ocean Beach, San Francisco, vicinity of Taraval Street 1980s, Photograph by Tim Britton